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TIME BUDGET OF BREEDING NORTHERN SHOVELERS

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McKinney (1970) suggested that the plankton-straining habits of Northern Shovelers (*Anas clypeata*) might require them to spend proportionately more time foraging than many other dabbling ducks. McKinney (1973, 1975) further suggested that a time consuming feeding method would entail special problems for breeding females and thus would have favored the evolution of the Northern Shoveler territorial system. This paper describes time budgets of Northern Shoveler pairs during the breeding season. Results are discussed in relation to the importance of stored body reserves and environmental food resources to breeding females.

STUDY AREA AND METHODS

The study was conducted near the Delta Marsh in south central Manitoba, Canada. Observations of pairs were made in the aspen parklands adjoining the marsh. The area has been described by Conner (1939), Hochbaum (1944), Löve and Löve (1954), Sowls (1955), Ellis (1959), and Bird (1961).

Shovelers were captured with rocket nets, decoy traps (Blohm and Ward 1979), or nest traps (Weller 1957), and individually marked with nasal saddles (Sugden and Poston 1968). Some unmarked individuals were identified by variations of plumage and bill edge coloration. Observations were made with binoculars (7×) or a telescope (20–45×) from a truck and recorded with a portable tape recorder.

Time budgets of pairs were calculated during spring arrival, prelaying, and laying in 1975 by procedures similar to those of Dwyer (1975). Activities of pair members were continuously recorded during 1 h sampling periods randomly selected from 3 periods of the day, 05:00–10:00, 10:00–15:00, and 15:00–20:00. Activities were separated into 7 categories: (1) feeding; (2) resting (loafing and sleeping); (3) comfort movements; (4) locomotion (walking, swimming, and flying not associated with aerial pursuits); (5) alert; (6) social interactions (threats, chasing, pursuit flights, and inciting); and (7) out of sight. Calculations of the percent of time spent in various activities were based on the amount of time individuals were actually observed. Time budgets of incubating females were determined during recesses (periods off the nest). I observed marked females at known incubation stages by waiting for the hen to leave the nest and then continuously recording her behavior until she returned. Only complete, undisturbed sampling periods and recesses were analyzed. Sexual differences in activities within breeding stages were determined by paired t tests.

RESULTS

Spring arrival.—Upon arrival on the breeding grounds in mid April, flocks of pairs occupied shallow depressions in stubble fields and flooded meadows adjacent to the marsh. Paired males were generally non-aggressive upon arrival, and pairs often fed or rested within 1 m of each

TABLE 1

PERCENT OF TIME SPENT IN VARIOUS ACTIVITIES BY NORTHERN SHOVELER PAIRS DURING SPRING ARRIVAL (N = 12 H), PRELAYING (N = 18 H), AND LAYING (N = 13 H), AND BY FEMALES DURING 11 INCUBATION RECESSES

Breeding stage	Percent of time spent					
	Feeding	Resting	Comfort movements	Locomotion	Alert	Social interactions
Spring arrival						
males	63.5	18.5	6.3	3.0	7.4	1.3
females	68.9	16.1	10.3	1.8	2.6	0.3
Prelaying						
males	54.2	21.6	12.1	5.8	4.8	1.5
females	58.4	24.1	11.4	3.1	2.8	0.2
Laying						
males	34.9	14.7	19.0	6.8	24.3	0.3
females	57.1	18.6	17.9	2.0	4.3	0.1
Incubation						
females	68.3	1.1	23.3	4.6	2.6	0.1

other. Hostility increased after unpaired males arrived, and paired males began defending an area of 1 to 3 m radius around their mobile females (Seymour 1974, Afton 1977).

Pairs spent most of the daylight hours feeding or resting during spring arrival (Table 1). Females devoted more time to comfort movements ($P < 0.01$), while males spent more time in social interactions ($P < 0.02$). Pair members spent similar amounts of time feeding, resting, alert, and in locomotion ($P > 0.05$).

Prelaying.—Within 1 to 2 weeks after arrival, pairs dispersed from flocks and established breeding territories (Seymour 1974). All observations during prelaying were of territorial pairs. Territories were defended for a minimum of 10 to 18 days prior to laying ($\bar{x} = 14.2$, SE = 1.5, N = 5).

Daily activities of 4 pairs consisted primarily of feeding and resting during prelaying (Table 1). Foraging rates of females were significantly greater than those of their mates ($P < 0.02$). Males spent more time than females in locomotion ($P < 0.02$), alert behavior ($P < 0.02$), and social interactions ($P < 0.02$). Pair members devoted similar amounts of time to comfort movements and resting ($P > 0.05$).

Laying.—Females spent increasing amounts of time on the nest as laying progressed. The relationship was best described by the equation Y =

$0.027 + 0.585X^2$ ($F = 108.237$, $P < 0.001$, $r^2 = 0.857$), where Y = proportion of day spent on the nest, and X = proportion of clutch completed (Afton 1977). Thus, a hen with a 10 egg clutch spent, on the average, 74.8% of her time during the laying stage off the nest.

Table 1 shows daily activities of 5 pairs when females were off their nests during the laying stage. Females spent significantly more time feeding than did males ($P < 0.001$). Correspondingly, males spent more time alert ($P < 0.001$) and in locomotion ($P < 0.01$) than females. Comfort movements, resting, and social interactions consumed similar amounts of time for pair members ($P > 0.05$).

Seasonal trends in activities.—General trends are evident in the daily activities of pairs during the breeding season (Table 1). Foraging rates declined for both sexes as the season progressed, but the decline was much greater for males (28.6% vs. 11.8%). Females fed more intensively than their mates in all 3 breeding stages. Continuous foraging bouts of hens averaged 3.5 min (SE = 0.5, N = 113), 3.6 min (SE = 0.4, N = 129), and 4.4 min (SE = 0.7, N = 76) during spring arrival, prelaying, and laying, respectively; those of drakes averaged 1.9 min (SE = 0.2, N = 195), 1.9 min (SE = 0.2, N = 228), and 1.2 min (SE = 0.1, N = 193). Feeding occurred during all daylight hours, while resting increased during midday in all breeding stages. During prelaying and laying, females typically fed while their mates were involved in social interactions with conspecifics. Comfort activities increased for both sexes during the season. Males spent considerably more time alert during laying than in the previous stages.

Incubation recesses.—During the 23 day incubation period, females spent an average of 221.3 min (SE = 6.9, N = 120) off the nest each day (Afton 1977). Recess activities of 6 hens consisted mainly of feeding and comfort movements (Table 1). The proportion of time spent feeding during recesses increased throughout incubation, while time spent in comfort movements and locomotion decreased (Fig. 1). Other activities showed no significant relationship to stage of incubation. The paired male was usually present on the territory and immediately swam or flew to his mate when she arrived from the nest. He remained alert and in constant attendance for the duration of the recess.

DISCUSSION

Sexual differences in foraging rates apparently reflect differential energetic costs of reproduction. The caloric cost of egg production is relatively high for anseriforms (King 1973, Ricklefs 1974), and breeding ducks require

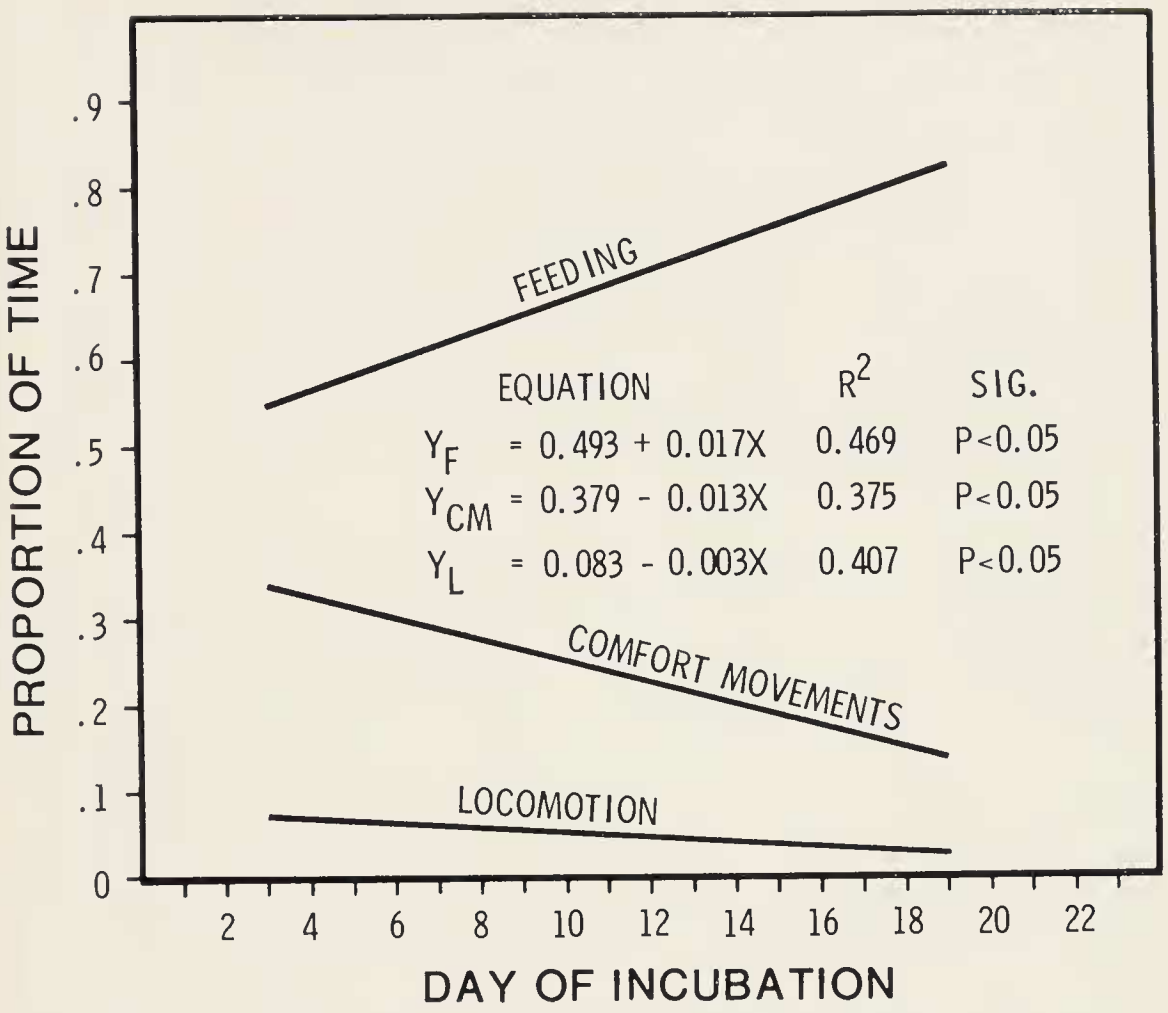

FIG. 1. Relationship of the proportion of time spent feeding, in comfort movements, and in locomotion during incubation recesses (N = 11) to stage of incubation, for 6 female Northern Shovelers.

large amounts of protein in the form of aquatic invertebrates (Holm and Scott 1954, Krapu and Swanson 1975). Similar sexual differences in foraging rates have been reported for other anatids during the breeding season (Bengtson 1972, Titman 1973, Dwyer 1974, 1975, Milne 1974, Swanson et al. 1974, Ashcroft 1976, Derrickson 1977, Stewart 1977, Seymour and Titman 1978).

My data do not support McKinney's (1970) hypothesis that the Northern Shoveler's feeding method is relatively more time consuming when compared to time budget data for other *Anas* species (Titman 1973, Dwyer 1975, Miller 1976, Derrickson 1977, Stewart 1977, Seymour and Titman 1978). Additional studies on time and energy expenditures of breeding ducks are clearly needed. However, interspecific comparisons of feeding rates must be made with caution as species differ in body size, foraging methods, diets, and possibly in the amount of time spent feeding at night.

Northern Shoveler hens apparently rely primarily upon breeding ground food resources for reproduction. Upon arrival on the breeding grounds, hens spend approximately 3 weeks mostly feeding and accumulate endogenous reserves (Afton in prep.) that are used during laying and incubation. In contrast arctic nesting geese and possibly early nesting dabbling ducks (e.g., Pintails, *Anas acuta*) rely almost exclusively on endogenous reserves acquired prior to arrival on the breeding grounds (Ryder 1970, Krapu 1974, MacInnes et al. 1974, Ankney 1977, Ankney and MacInnes 1978).

Shoveler hens support their metabolism during incubation through periodic foraging and by relying heavily on stored body reserves (Afton in prep.). However, I believe environmental food resources are critical to successful incubation because: (1) females foraged most of their time off the nest; (2) the proportion of time spent feeding during recesses increased throughout incubation; (3) shovelers were correspondingly less attentive to their nests than larger anatids (Afton 1977); (4) gizzards of female shovelers did not decrease in size during incubation (Afton in prep.), unlike those of Common Eiders (*Somateria mollissima*) (Cantin et al. 1974, Milne 1976) and Lesser Snow Geese (*Chen caerulescens caerulescens*) (Ankney 1977) which feed little during incubation; (5) paired males maintained territories, on the average, until day 21 of incubation, the same day on which females markedly increased nest attentiveness (Afton 1977); and (6) 1 marked hen, whose mate was killed in early incubation, deserted her nest 4 days after another pair established on the same territory. Harassment by the new paired drake prevented the marked hen from feeding during recesses. Thus, I believe the desertion resulted from insufficient foraging time.

The apparent crucial importance of environmental food resources to shoveler hens during incubation contrasts the situation found in geese (Ryder 1970, Harvey 1971, Cooper 1978, MacInnes et al. 1974, Ankney 1977, Ankney and MacInnes 1978) and Common Eiders (Milne 1974, 1976, Korschgen 1977) which rely almost exclusively on stored body reserves. These larger anatids maintain high nest attentiveness which is adaptive in reducing the exposure of eggs to weather and predation. Due to their relatively small body size, shoveler hens probably are unable to store sufficiently large amounts of body reserves to carry them through incubation, and therefore, must rely heavily on environmental food resources. Available data support the hypothesis that small female anatids rely to a greater extent on food resources during incubation (Table 2).

Shoveler males maintained isolation for their mates through territorial defense. Consequently, foraging bouts of hens were rarely interrupted after territory establishment. The successive decline in male feeding rates partially resulted from increased time spent alert and swimming with head

TABLE 2

ESTIMATED FEEDING TIME DURING INCUBATION FOR 4 ANATIDS

Speeics	Ineubation period (days)	Mean time off nest/day (min)	Proportion of time spent feeding	Feeding time/day (min)	Total feeding time (h)
Branta canadensis[a]	27	20.2	0.377	7.6	3.4
Anas platyrhynchos[b,c]	26	78.0	0.674	52.6	22.8
Anas clypeata[d]	23	221.3	0.683	151.1	57.9
Anas discors[e]	23	289.0	0.600	173.4	66.5

References: [a] Cooper (1978), [b] Caldwell and Cornwell (1975), [c] Titman (1973), [d] Afton (1977), [e] Miller (1976).

upright. Both activities were important for successful territorial defense and probably also had predator escape functions. Drakes were probably able to reduce foraging time because of increasing food resources due to higher air temperatures and longer photoperiods (Dwyer 1975) and/or perhaps by relying partially on stored body reserves.

In general, my data support the contentions of McKinney (1973, 1975) and Seymour (1974) that defense of a territory is advantageous in securing a needed food supply for the hen and providing her with undisturbed feeding time. Since the hen's reproductive success is critically dependent on breeding ground food resources, the male's fidelity to his mate and persistent defense of a feeding territory is necessary to assure his own reproductive success. Thus, I believe that the female's strategy in obtaining energy for reproduction has been an important factor in the evolution of the Northern Shoveler breeding system.

SUMMARY

Behavior of Northern Shoveler pairs was studied during the 1975 breeding season near Delta, Manitoba. Time budget analysis indieated that paired females spent approximately 3 weeks, mostly feeding, on the breeding grounds prior to laying. Sexual differenees in foraging rates were deteeted, and apparently refleet differential energetie eosts of reproduetion. Paired males maintained isolation for their mates through territorial defense. Consequently, foraging bouts of hens were rarely interrupted after territory establishment. Environmental food resources were apparently eritieally important for sueeessful ineubation. The female's strategy in obtaining energy for reproduetion may have been an important faetor in the evolution of the Northern Shoveler breeding system.

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